ENVIRONMENTAL ASSESSMENT

for the

Gemini Northern 8-Meter Telescope
Mauna Kea, Hawaii

December 1993

Prepared by

ENGINEERING-SCIENCE, INC.
DESIGN • RESEARCH • PLANNING
1301 MARINA VILLAGE PARKWAY, ALAMEDA, CA 94501 • 510/769-0100
OFFICES IN PRINCIPAL CITIES
NC427/49-02

ENGINEERING-SCIENCE

ENGINEERING-SCIENCE, INC.

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10 December 1993
Ref: NC427

Dr. G. Wayne Van Citters
National Science Foundation
Division of Grants and Contracts
1800 G. Street, N.W., Room 615
Washington, D.C. 20550

Dear Mr. Van Citters:

Enclosed are 15 copies of the revised Environmental Assessment (EA) for the Gemini Northern 8-Meter Telescope. We have also sent one copy to Carol A. Langguth as per the contract No. AST-9319521.

A number of changes were made in response to the comments on the first draft. While many of these were minor, we wanted to highlight the more major changes. We have removed Appendix A due to the confusion caused by the text. The Archaeology section has been expanded slightly so that all critical information is included. The Construction section has been revised to reflect changes for Phases I and II. We have scaled back the mitigation for air quality impacts as suggested, but have left in most discussions of impacts because we feel that it is important to document the insignificance of operational emissions. The Land Use section has a new paragraph regarding the Coastal Zone Management Plan, as this issue was identified in the checklist at the back of the report. All references to operating and construction costs have been removed. Finally, major deletions were made to the Geology/Volcanology section in order to focus on the critical issues.

We hope that the document, as revised, is satisfactory and that we have adequately responded to all the comments. We want to thank you for your help. If you have any questions, please do not hesitate to call me or Amy Skewes-Cox (510/769-0100). When it is convenient, we would appreciate receiving the background documents that we submitted with the last report.

Sincerely,

ENGINEERING-SCIENCE, INC.

Robin Cort

Robin Cort, Ph.D.
Project Manager

RC/amb/51-59.R1
Enclosure

cc: Carol A. Langguth (with 1 copy)

PARSONS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SECTION 1

PURPOSE AND NEED FOR PROPOSED PROJECT

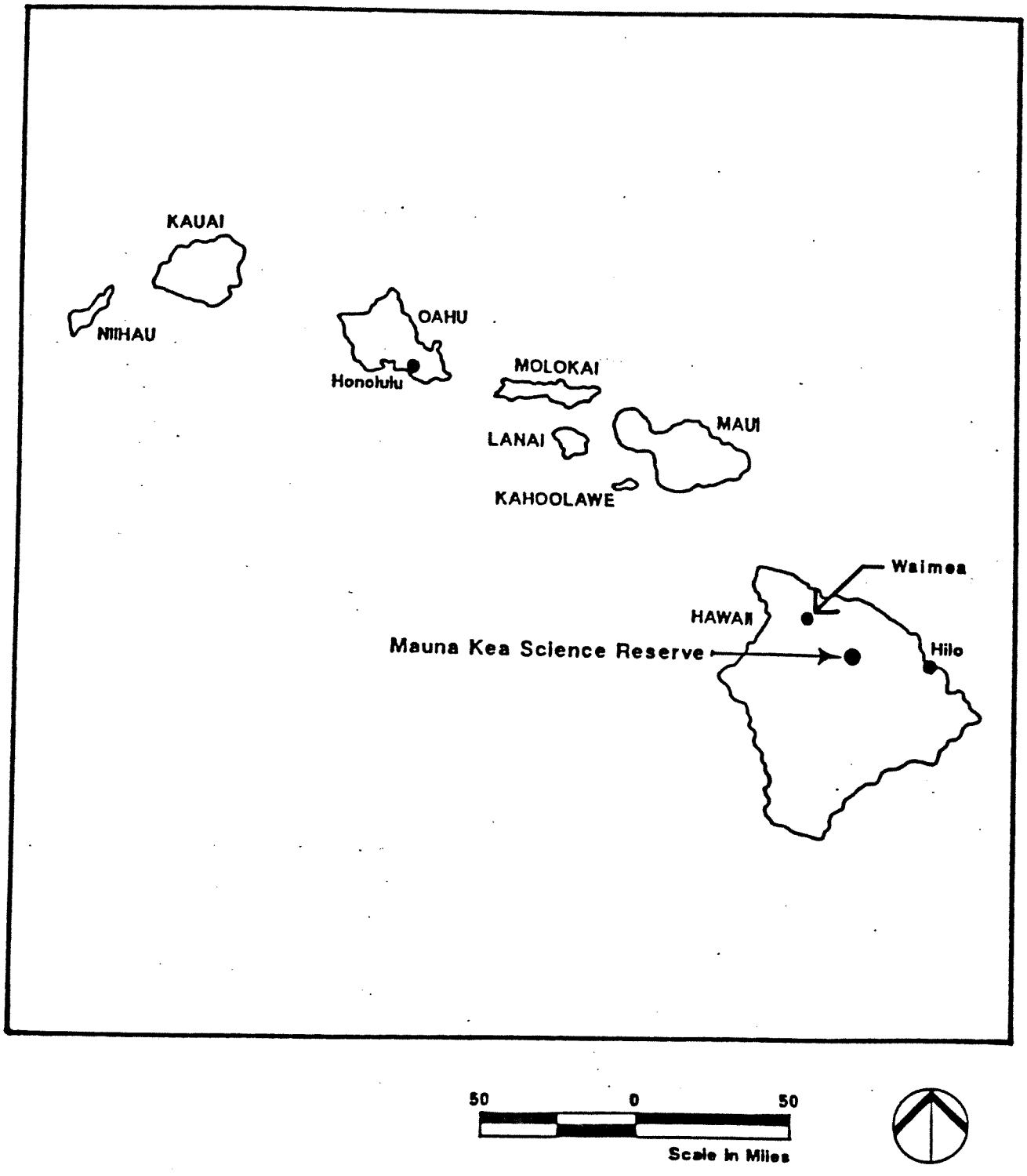
1.1 OVERVIEW AND PURPOSE

The Gemini 8-Meter Telescopes Project is an international partnership of the United States, and five other countries to construct and operate two 8-meter optical/infrared telescopes at two sites -- one in the northern hemisphere and one in the southern hemisphere. The Gemini telescopes would be international facilities available to astronomers from the partner countries on an open basis according to the merit of their research proposals. The U. S. would provide 50 percent of the funding for the Telescopes Project. Other members of the partnership and their proportionate interests in the project are: United Kingdom (25 percent), Canada (15 percent), Chile (5 percent), Argentina (2.5 percent) and Brazil (2.5 percent). The National Science Foundation (NSF) has been designated the Executive Agency for the project and in this capacity, has proposed locating the Gemini Northern 8-Meter Telescope in the State of Hawaii on the island of Hawaii, the southernmost island of the Hawaiian chain (Figure 1.1-1). The southern telescope, which is not addressed in this Environmental Assessment, would be located on Cerro Pachon in Chile.

NSF has asked the University of Hawaii Institute for Astronomy (UH IfA) for permission to locate the Gemini Northern 8-Meter Telescope within the summit area of the Mauna Kea Science Reserve (Figure 1.1-2). In recognition of the key role of UH IfA in developing and operating Mauna Kea as an international site for astronomy, UH astronomers would have a guaranteed share of the observing time on the Gemini Northern Telescope.

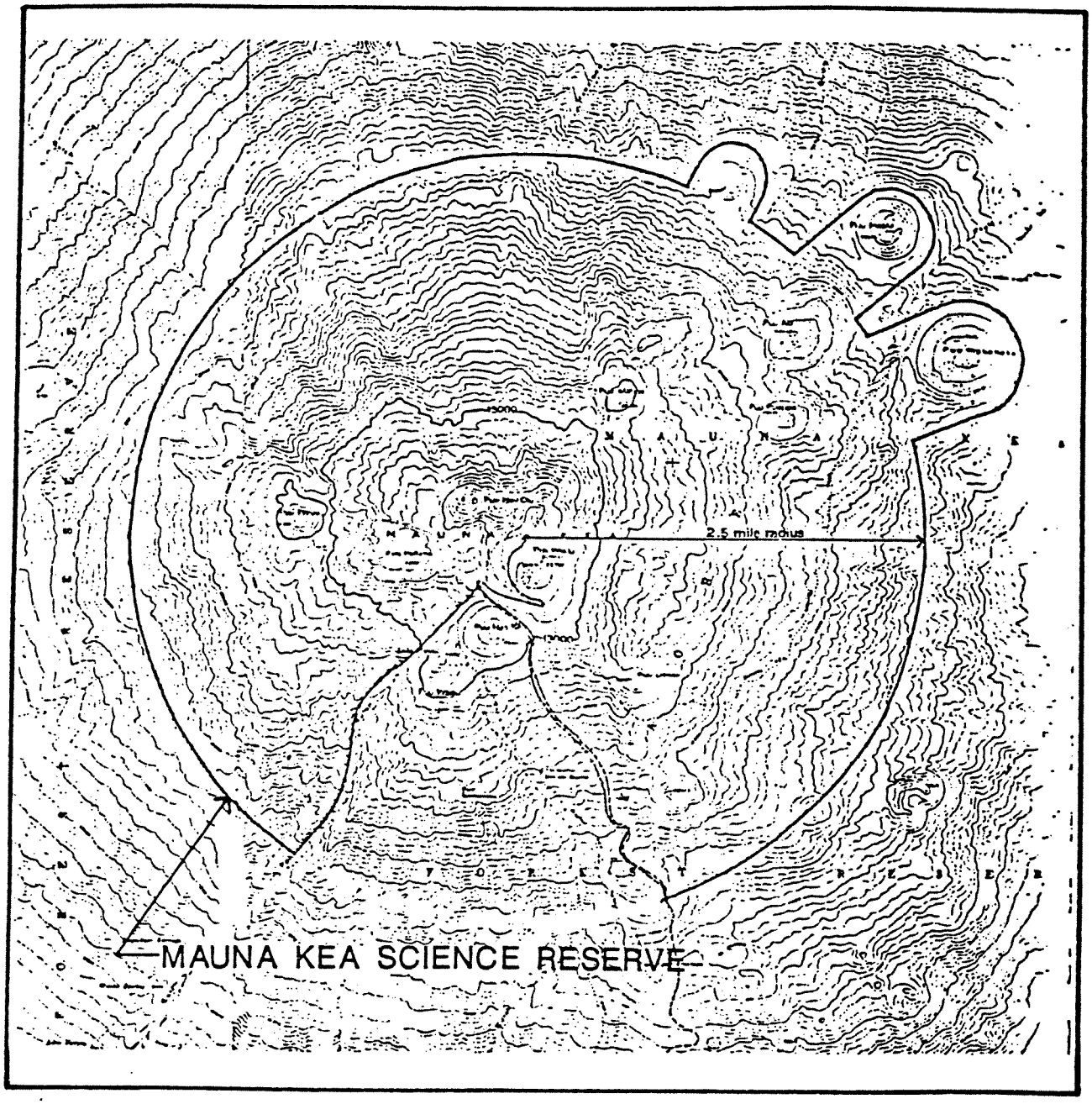
1.2 NEED FOR PROJECT

The Gemini telescopes would produce fundamental advances in the study of objects ranging in distance from within our own solar system to within ten percent of the observable horizon of the universe. For example, astronomers would study disks around nearby stars, thought to be remnants of planetary formation, and map them with a resolution corresponding to the scale of the earth's orbit around the sun. In the nearest regions of our galaxy, the Gemini telescopes would be able to study protostellar objects down to the scale of Jupiter's orbit and thereby find clues about what leads to protostellar collapse in dense clouds of interstellar gas. Astronomers would use these telescopes to study how the abundance of chemical elements evolved in the Universe from the



STATE OF HAWAII

FIGURE 1.1-1



MAUNA KEA SCIENCE RESERVE

FIGURE 1.1-2

primordial constituents, hydrogen and helium. This analysis would be accomplished by studying the oldest stars in the Milky Way together with quasars so distant that their light now reaching us was emitted when the universe was less than a quarter of its present age.

One Gemini telescope would be located in the northern hemisphere and one in the southern hemisphere to allow access to key astronomical objects, regardless of their location on the celestial sphere. In other words, all objects accessible to space observatories throughout the world would be observable with the Gemini telescopes.

The telescopes would be designed to have similar capabilities, consistent with scientific requirements. The similarity would: (1) give similar performance in programs spanning both hemispheres, (2) facilitate the observing process for astronomers using both telescopes, and (3) enable the interchange of instruments and software between the telescopes. The similarity would also provide significant savings in cost and give practical advantages in design, manufacture, installation and operation. Unlike the Gemini telescope in the southern hemisphere, the Gemini Northern 8-Meter Telescope would be infrared optimized and would have a different complement of instrumentation at first light.

The Gemini telescopes would use a monolithic (single-piece) primary mirror over eight meters in diameter and would be among the largest and most technologically advanced telescopes in the world. They would offer a unique combination of large light-gathering power (from the 8-meter mirror), image sharpness, and high performance in the optical and infrared wavelength bands. As a result, the Gemini telescopes would be more than ten times as powerful as the current generation of 4-meter-class telescopes. To fully exploit these capabilities, it is essential that the telescopes be located at the best possible sites.

The proposed site for the northern telescope, Mauna Kea, Hawaii, is regarded as the best available site in the world for an infrared-optimized telescope in terms of its 0.4 arc sec median seeing, 4,200 meter elevation, and 1 -2 millimeter (mm) typical level of water vapor. It is also the best site for ultraviolet observations. The Gemini Northern 8-Meter Telescope would be optimized for use in the infrared so as to exploit Mauna Kea's unique advantages for this type of observation.

SECTION 2

DESCRIPTION OF THE PROPOSED PROJECT

2.1 PROJECT LOCATION

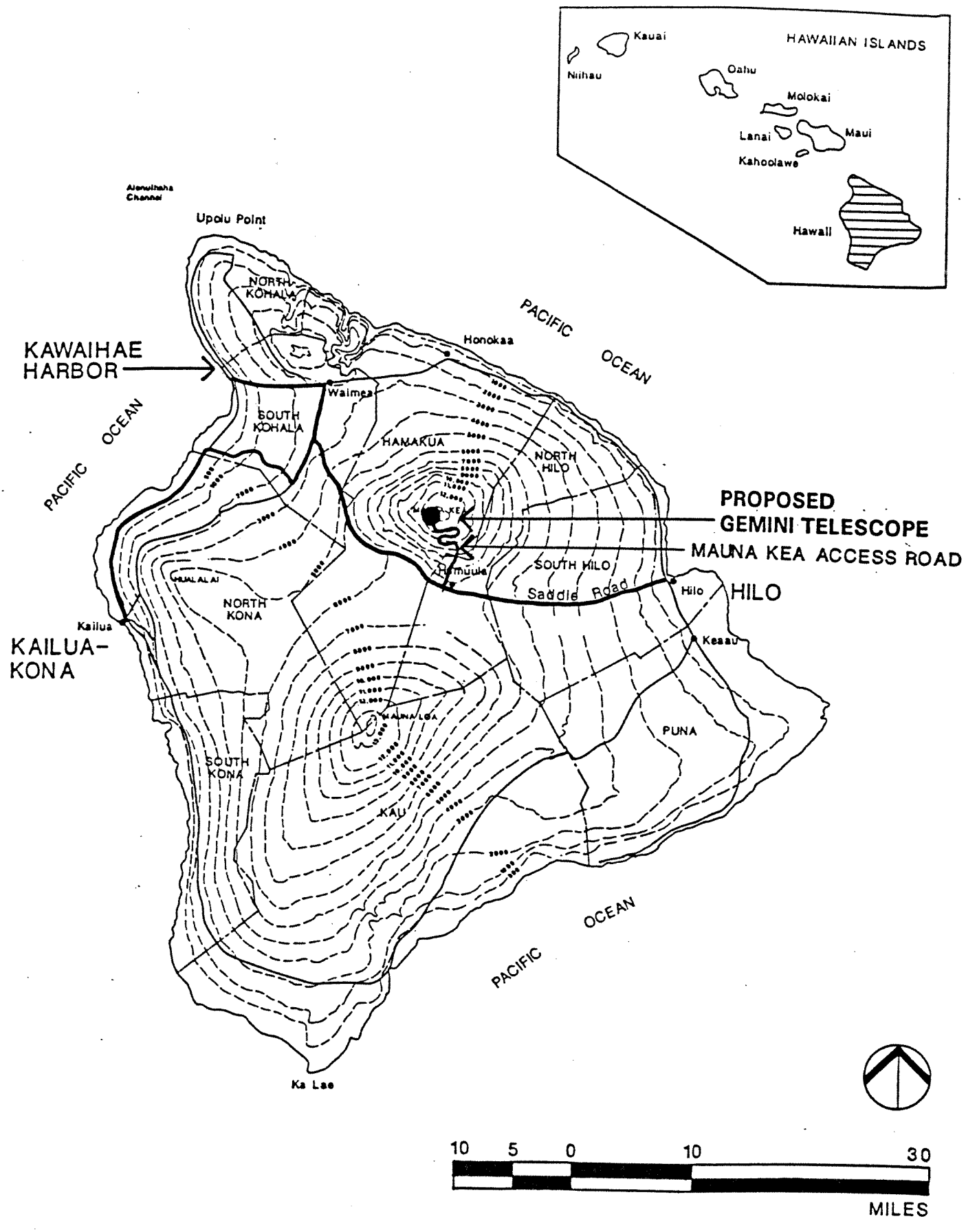
Mauna Kea Science Reserve

The Gemini Northern 8-Meter Telescope is proposed to be located within the Mauna Kea Science Reserve at the summit of Mauna Kea, a 13,796-foot-high shield volcano located on the island of Hawaii, the southernmost island of the State of Hawaii (Figure 1.1-1). The Mauna Kea Science Reserve (Figure 1.1-2) encompasses an area of about 11,200 acres of State of Hawaii land that is leased to the University of Hawaii (UH) and situated above the 12,000-foot elevation above mean sea level (msl) of the mountain. The lease states that the Science Reserve is to be used "... as a scientific complex, including without limitation thereof an observatory, and as a scientific reserve ... a buffer zone to prevent the intrusion of activities inimical to said scientific complex (DLNR 1968)."

The drive from Hilo or Waimea to the upper elevations of Mauna Kea takes about 1 to 1.5 hours. Access is via the Saddle Road (Route 200), to Pu`u Huluhulu and from there via a 6-mile-long, 20-foot-wide paved portion of the Mauna Kea Access Road to Hale Pohaku, at 9,200 feet above msl. From Hale Pohaku, the Mauna Kea Access Road continues 8.3 miles to the summit (Figure 2.1-1). It is a gravel road to approximately the 11,800-foot elevation and paved from this elevation to the summit.

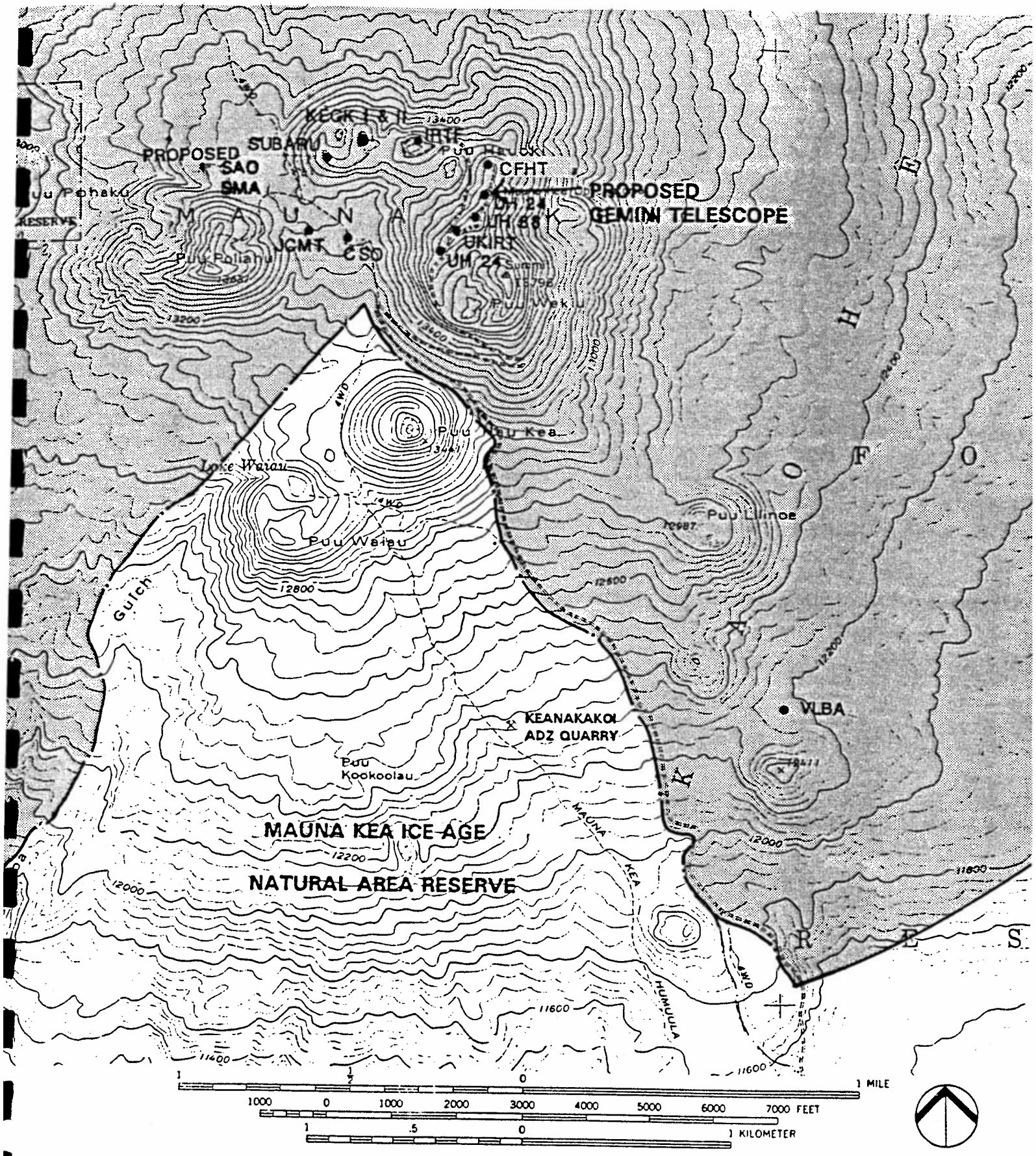
Presently, 11 telescopes and one antenna facility are either in operation or under construction within the Mauna Kea Science Reserve (Figure 2.1-2). These include seven major optical/infrared telescopes; two smaller (24-inch) telescopes; and two millimeter and submillimeter-wavelength telescopes. The Very Long Baseline Array (VLBA) Antenna Facility is located at the 12,200-foot elevation of the Mauna Kea Science Reserve. Telescopes on Mauna Kea by type and by year operational are listed in Table 2.1-1. Two additional telescopes, the proposed project and the Smithsonian Submillimeter Array, are presently proposed for the summit.

The proposed telescope site is located on the Mauna Kea summit ridge, between 13,750 and 13,780 feet above msl, between the Canada-France-Hawaii Telescope (CFHT) to the north and the UH 88-inch Telescope to the south (Figure 2.1-3). In order to provide an adequate site for the Gemini Northern 8-Meter Telescope, one of the 24-inch telescopes would be removed from the site.



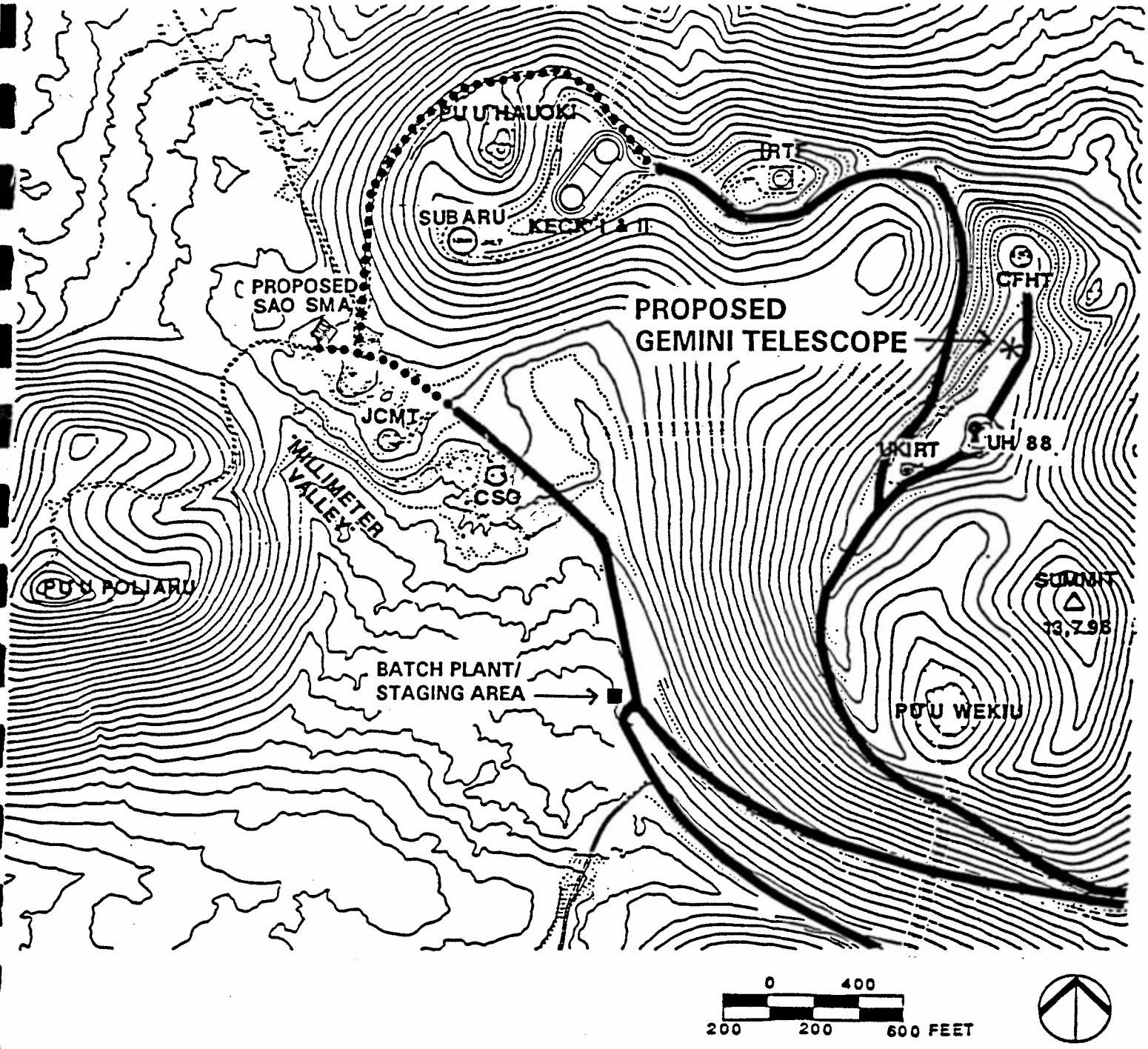
MAUNA KEA ACCESS

FIGURE 2.1-1



MAUNA KEA OBSERVATORIES

FIGURE 2.1-2



PROJECT LOCATION

FIGURE 2.1-3

TABLE 2.1-1

TELESCOPES ON MAUNA KEA BY YEAR OPERATIONAL

Telescope	Year Operational
Summit Ridge	
UH 24-inch Telescope	1968
UH 24-inch Telescope	1969
UH 88-inch Telescope	1970
NASA Infrared Telescope (IRTF)	1979
Canada-France-Hawaii Telescope (CFHT)	1979
United Kingdom Infrared Telescope (UKIRT)	1979
W.M. Keck Observatory (Keck I)	1992
W.M. Keck Observatory (Keck II)	1996*
Japan National Large Telescope (Subaru)	1999*
Millimeter Valley	
Caltech Submillimeter Observatory (CSO)	1987
James Clerk Maxwell Telescope (JCMT)	1987
12,220-Foot Elevation	
VLBA Antenna Facility (VLBA)	1993

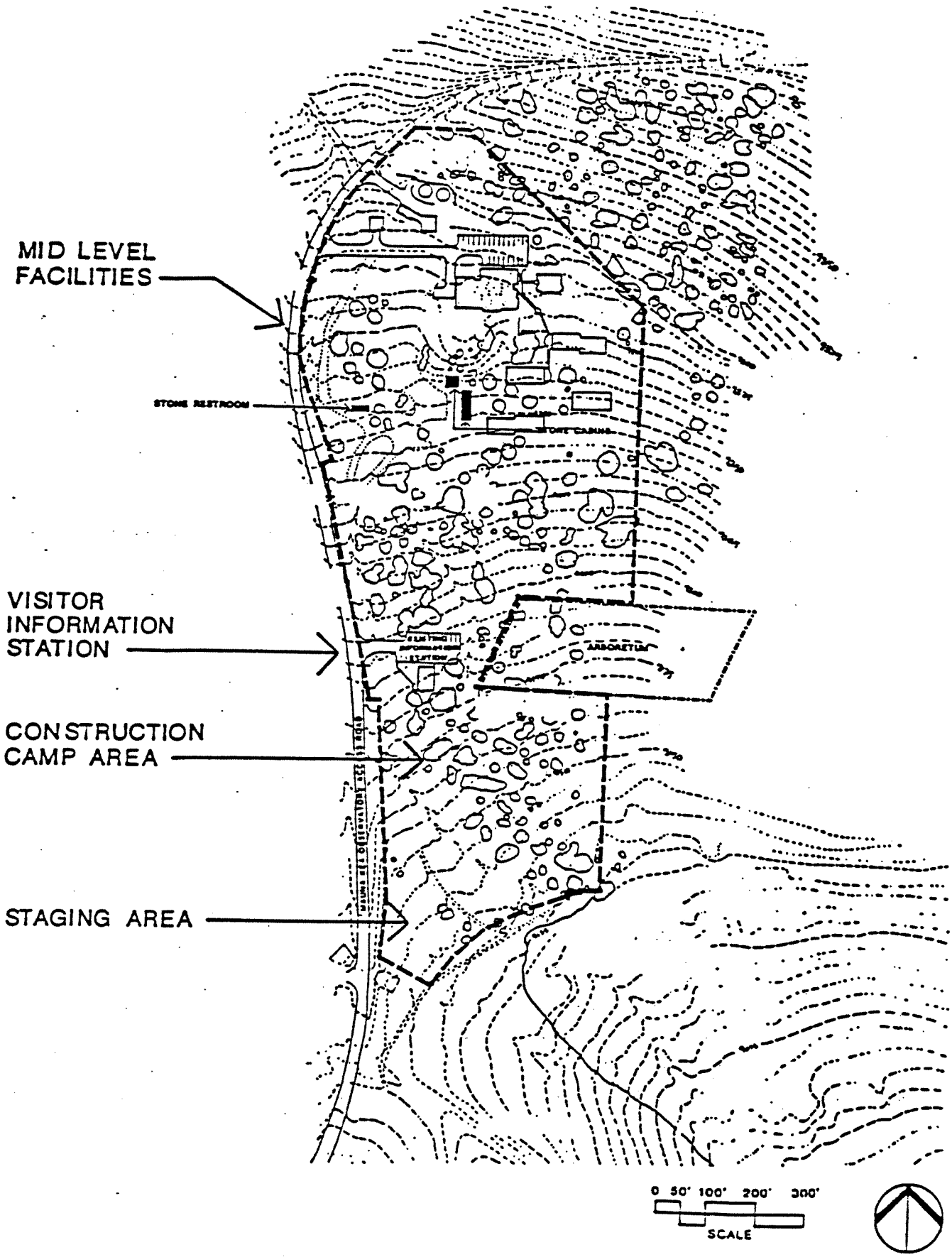
* Under Construction

All of the telescope facilities are used for basic astronomical research to study objects in our galaxy and in other galaxies. There are no military uses. Other scientific research that has been pursued in the summit area includes medical research on the effects of high altitude on the human body, meteorology, geology, biology and botany. Recreational uses within the Science Reserve include skiing, snowplay, hiking and sightseeing.

Hale Pohaku Mid-elevation Facilities

Because the summit of Mauna Kea is 13,796 feet above msl, it is inefficient and physically hazardous for people to travel directly from sea level to the summit and work without acclimatizing for a period of time at an intermediate elevation. Mid-elevation accommodations are provided at Hale Pohaku (9,300 feet above msl) for scientists and support staff so that they can remain acclimatized during their on-duty periods. UH is using a 19.3-acre parcel of state land between 9,120 and 9,340 feet above msl, just east of the Mauna Kea Access Road for this purpose. Approved uses of the parcel include: a mid-elevation facility for astronomers; an Information Station for the public, and a construction camp and materials staging area (Figure 2.1-4).

The Gemini project would purchase rooms in an existing dormitory and use the existing facilities at the construction camp. The project will also utilize the materials staging area from time to time.



HALE POHAKU LAND USE

FIGURE 2.1-4

2.2 PROPOSED PROJECT

8-Meter Telescope

Telescope Site

NSF intends to sublease an area of approximately two acres from the University of Hawaii (UH) (Figure 2.2-1). The telescope/access road development area would encompass about 1.2 acres. The telescope structure would occupy a circular level pad about 122 feet in diameter at a elevation of 13,758 feet above msl. The summit ridge spur road, which also provides access to the Canada-France-Hawaii Telescope, would be relocated around the east side of the Gemini facility. A support facility, loading and parking areas, mirror wash holding tank, septic tank with seepage bed and water storage tank would also be located on the site, as shown in the conceptual site plan (Figure 2.2-2).

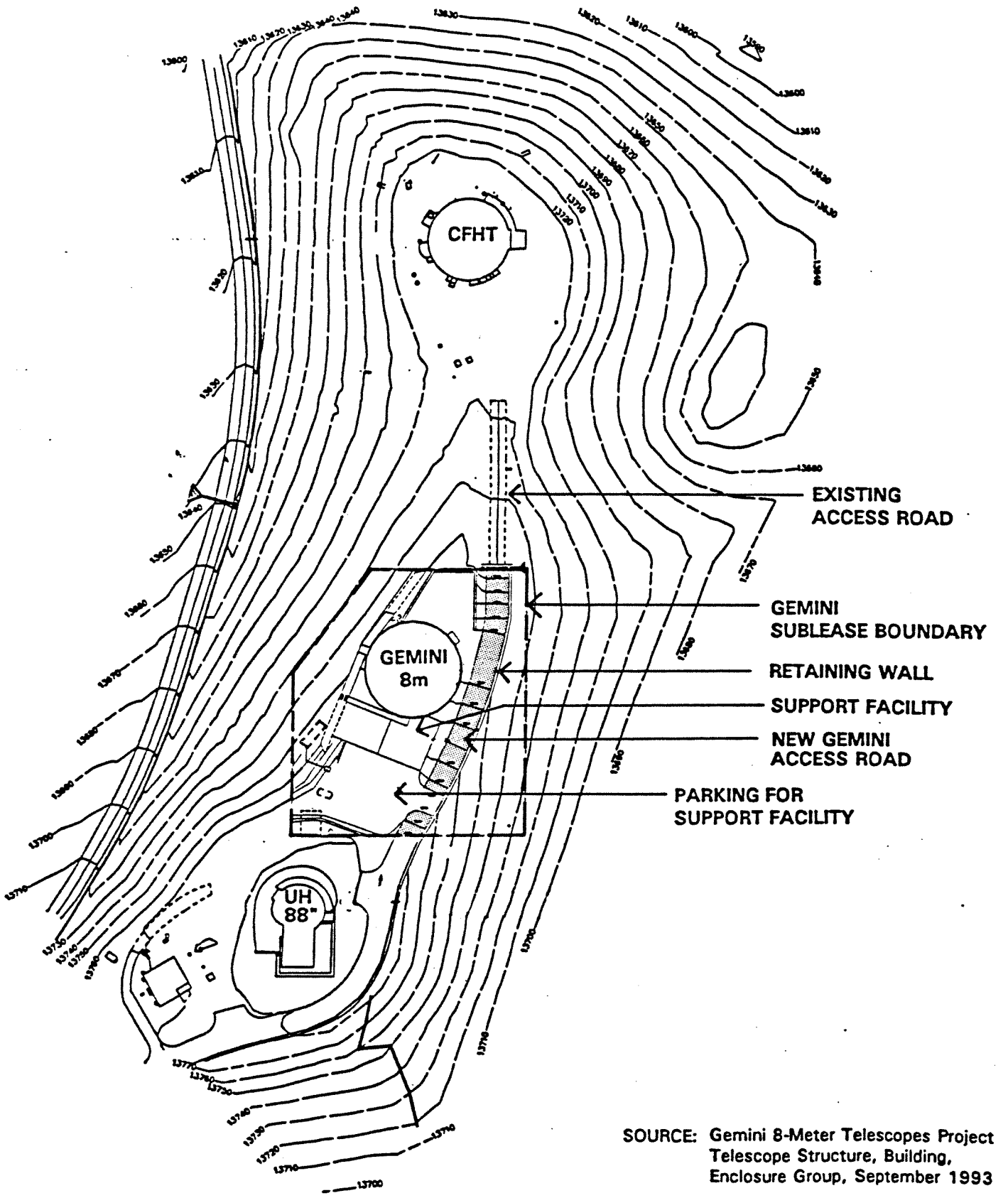
Telescope Enclosure and Appurtenant Structures

The telescope would be housed in a spherical/cylindrical enclosure with a dome diameter of 122 feet. The total height of the enclosure with respect to the lower floor level would be 132 feet. The rotating portion of the enclosure exterior would be finished with a diffuse metallic coating resembling oxidized aluminum. The exterior surface of the enclosure stationary base, the support facility roof and exposed support facility walls would be finished with a white titanium dioxide paint. An exhaust tunnel would collect and vent waste heat from the facility away from the sky observation areas. A perspective of the 8-meter telescope enclosure is shown on Figure 2.2-3. North-south elevations along the summit ridge, looking east and west, with approximate elevations of the UH 88-inch, Gemini 8-Meter and Canada-France-Hawaii telescopes are shown in Figures 2.2-4 and 2.2-5, respectively.

As shown on Figure 2.2-6, the lower floor level of the enclosure would be located at an elevation of 13,758 feet above msl. This space would be used for the mirror coating facility and telescope top-end maintenance. The coating facility would include a mirror stripping and wash area in addition to the coating plant itself. The mirror would need to be recoated every 6 to 24 months, depending on the reflective coating material used and cleaning method chosen.

A two-story support facility would be located adjacent to the telescope (Figures 2.2-2 and 2.2-6). In order to minimize wind flow and thermal disturbances, the support facility would be constructed partially underground. The lower level of this facility would have about 6,500 square feet of usable space. This space would contain the mechanical plant room, a workshop, instrumentation work space and a storage area for spare parts and equipment needed on site. The floor elevation of 13,758 feet above msl would be same as the lower floor level of the telescope enclosure.

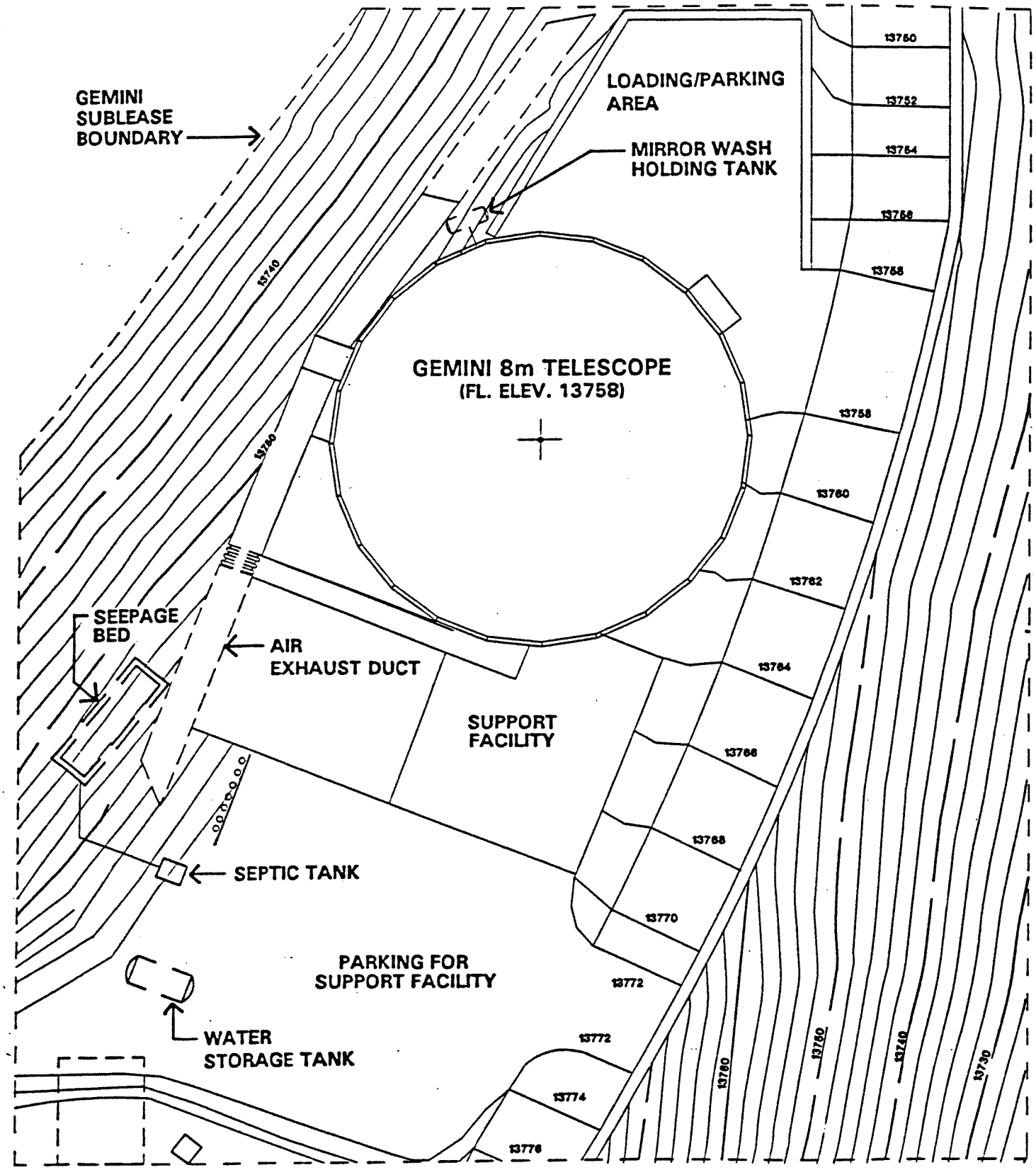
The 3,000-square-foot upper level of the support facility would be primarily used to house the computer room and the telescope operations room. The remaining space would be used for offices, an electronics lab, a break room, a public viewing gallery, storage and a restroom. Technicians and astronomers would access the telescope chamber via a



SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

SITE ACCESS AND LAYOUT

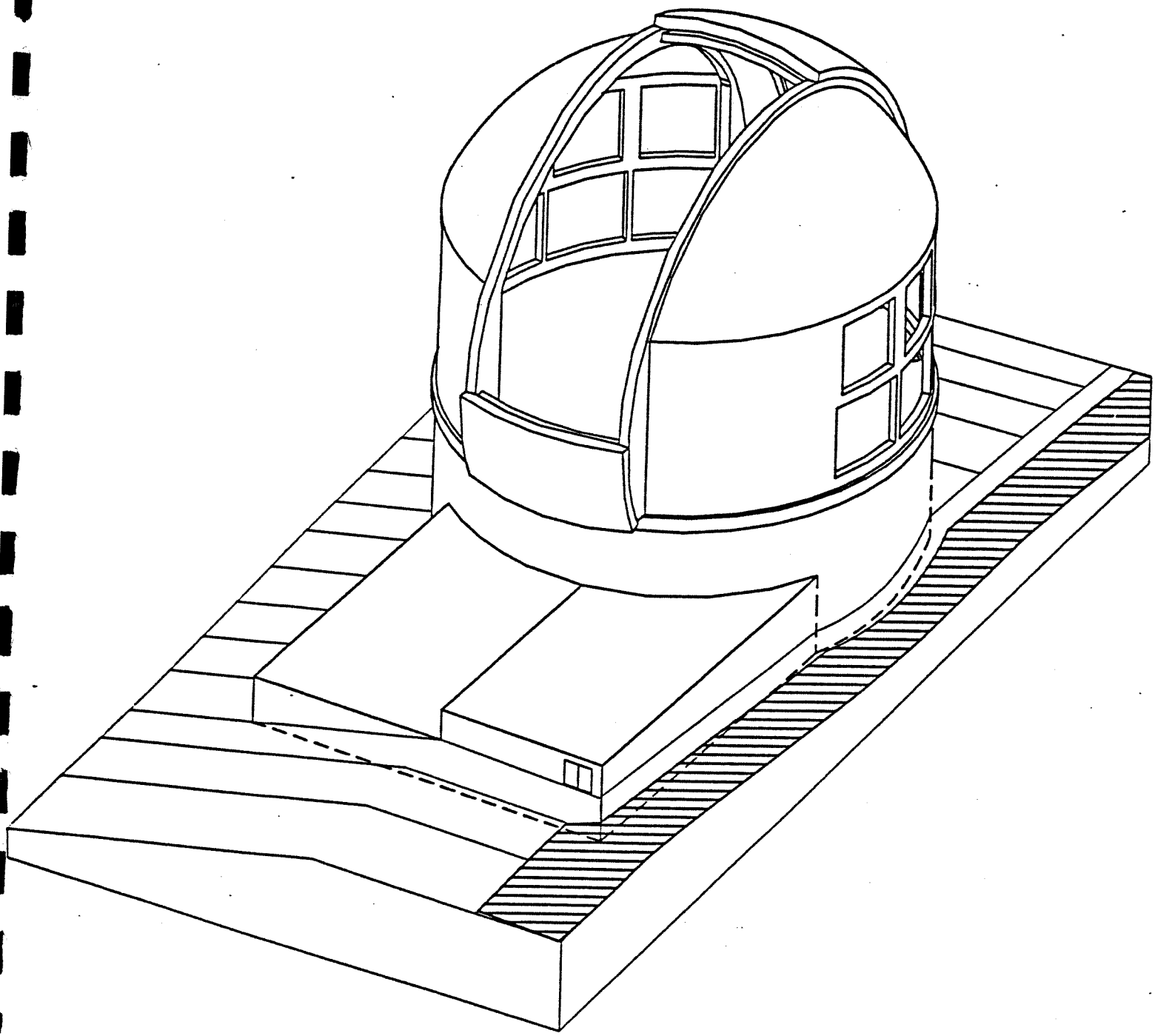
FIGURE 2.2-1



SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

CONCEPTUAL SITE PLAN

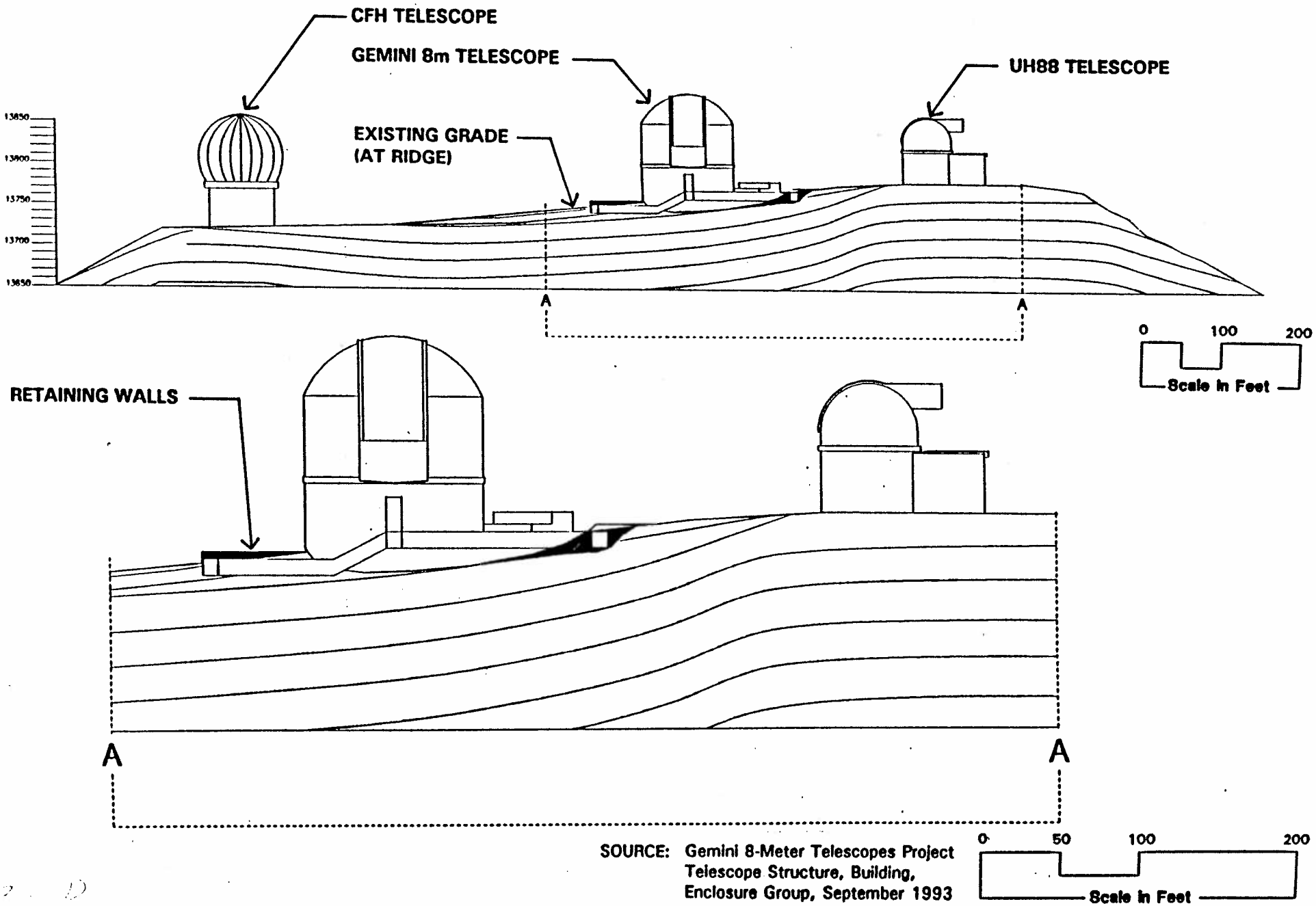
FIGURE 2.2-2



NO SCALE

SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, June 1993

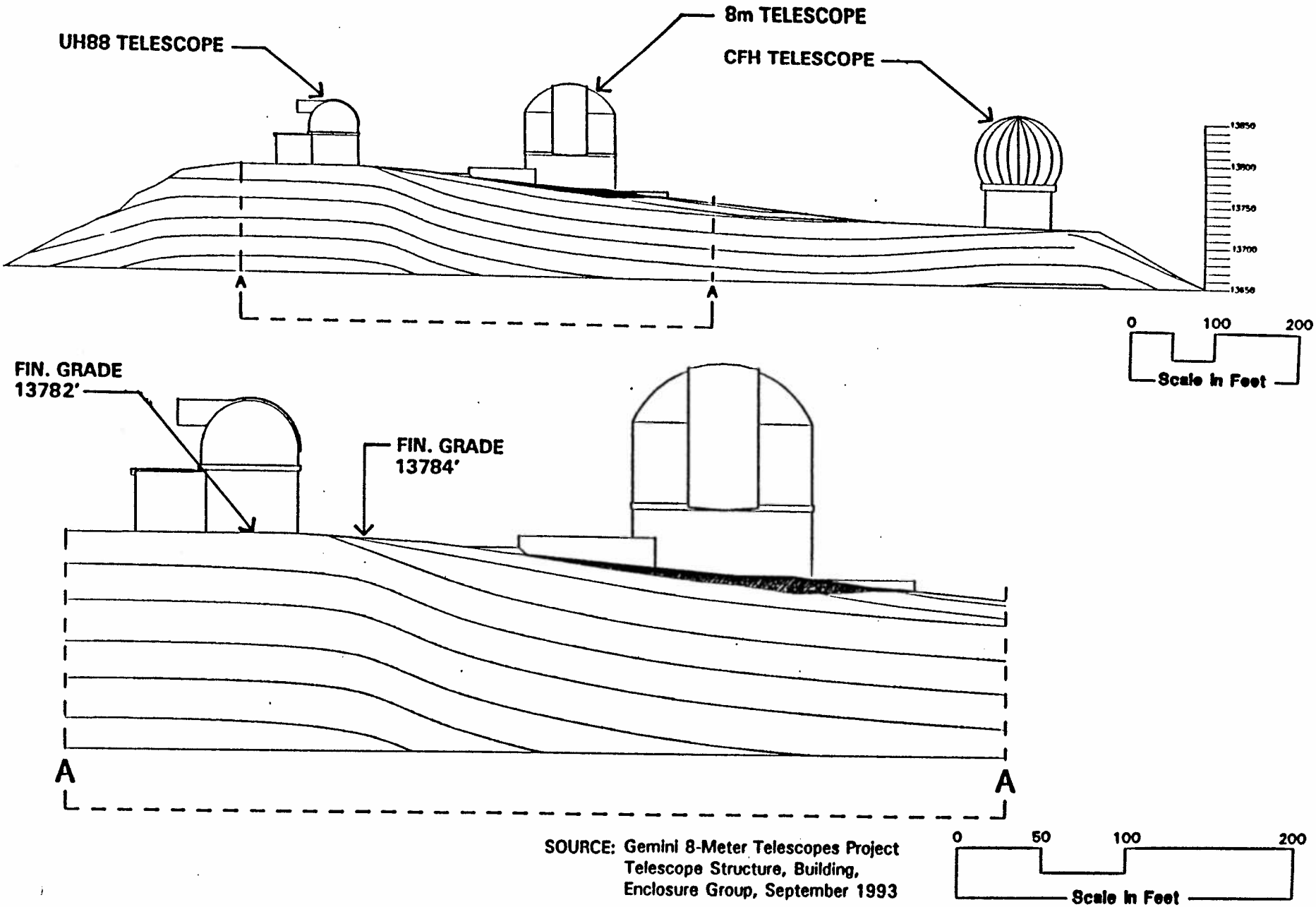
PERSPECTIVE OF 8-METER TELESCOPE ENCLOSURE



SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

NORTH-SOUTH ELEVATION ALONG RIDGE LOOKING EAST

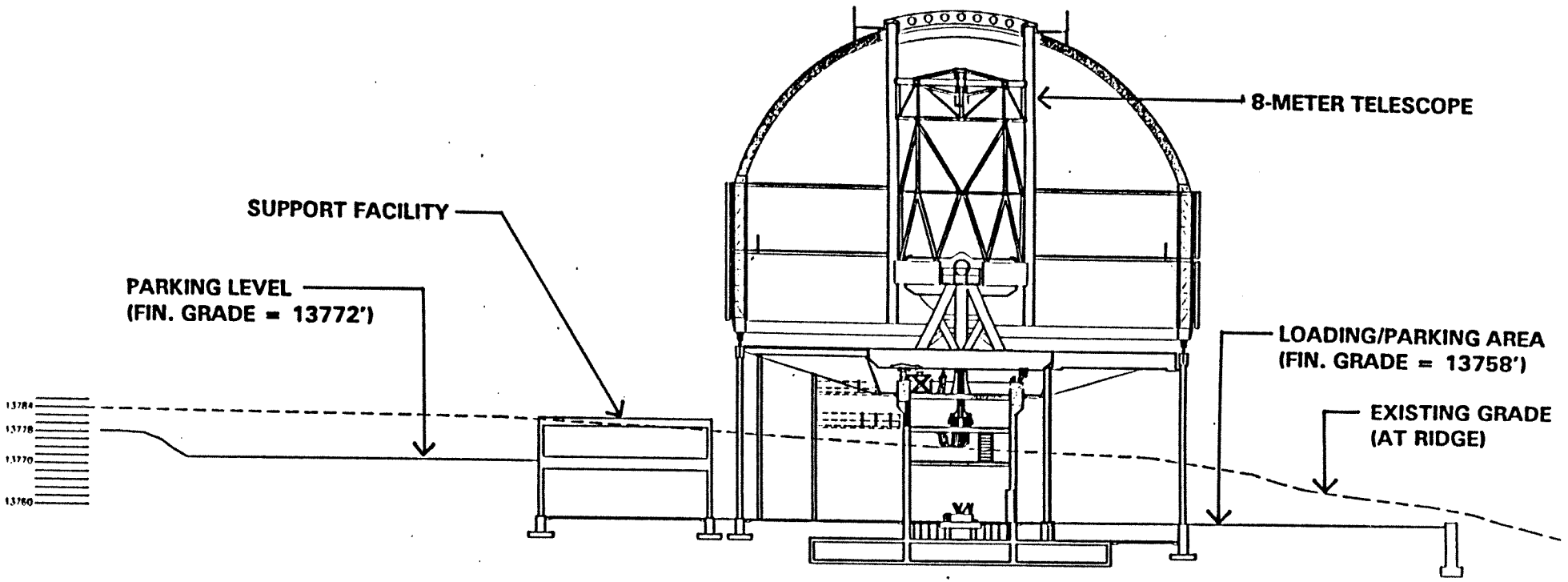
FIGURE 2.2-4



SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

NORTH-SOUTH ELEVATION ALONG RIDGE LOOKING WEST

FIGURE 2.2-5



0 12.5 25 50

Scale in Feet

SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

NORTH-SOUTH SECTION OF GEMINI SITE LOOKING WEST

FIGURE 2.2-6

stairway and elevator located within the enclosure, just north of the support facility. If additional floor space were required in the future, the upper level could be expanded across the entire lower level.

Infrastructure and Utilities

Access

Within the summit area, access to the telescope site would be along the existing paved access road to the UH 88-inch telescope. From there, the road would be realigned along the east side of the Gemini facility, rejoining the existing road north of the Gemini lease boundary (Figure 2.2-1). The slope of the new gravel-surfaced roadway section would be between 8 and 12 percent. In order to maintain sufficient road width, a 340-foot-long retaining wall with guardrail would be constructed on the east side of the road. The wall would have a maximum height of 12 feet. Construction materials being considered for the retaining wall are cast-in-place or precast concrete, colored to be compatible with the surrounding environment.

Power

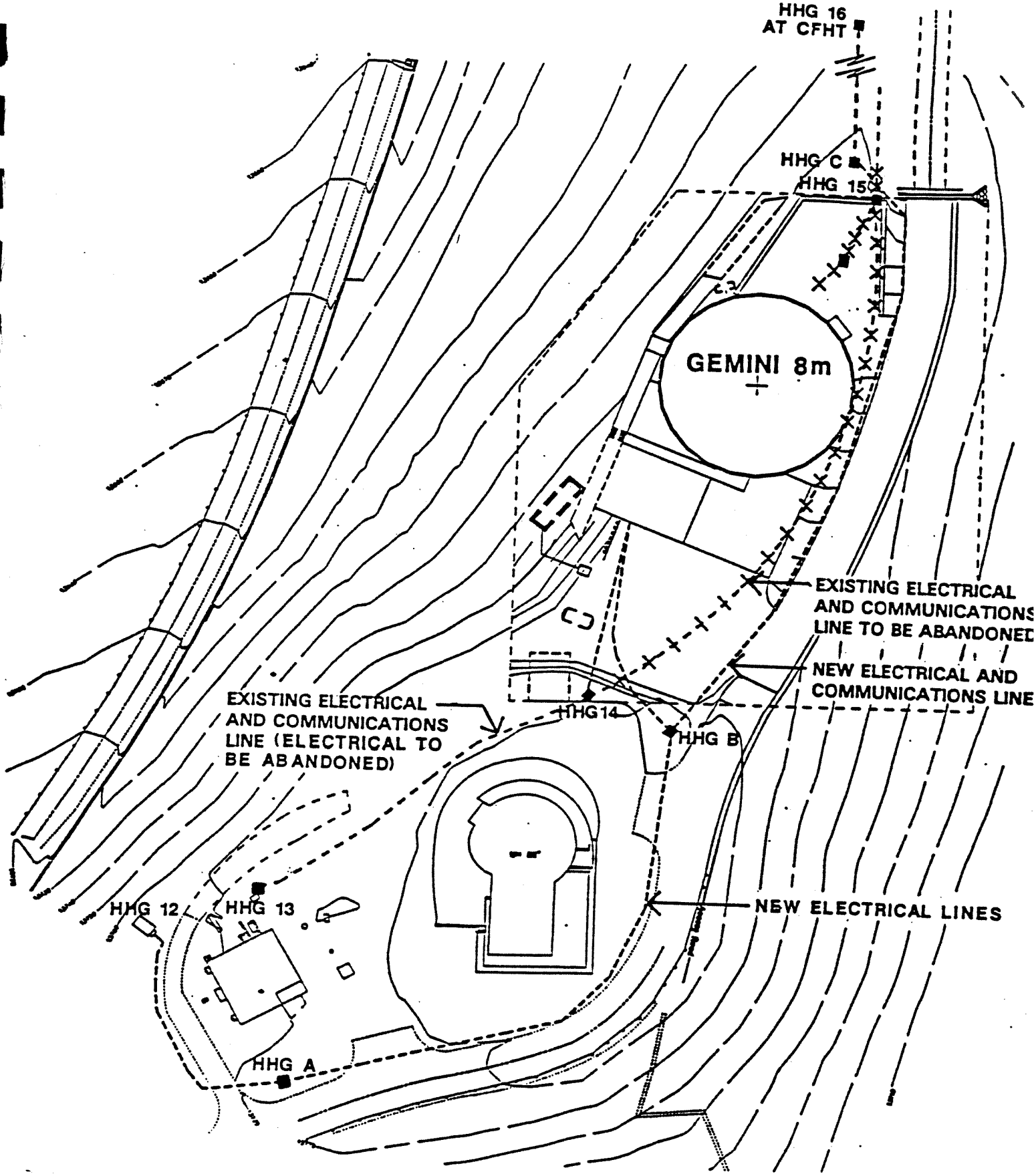
Commercial power to the project site would be provided by Hawaii Electric Light Company's (HELCO) existing underground 12.47 kilovolt (kV) line. A 750 kilovolt amps (kVA) transformer would be located near the telescope enclosure. Estimated energy consumption is approximately 2,000 kilowatt hours (kWh) per day. Access to existing utilities is provided by utility access vaults, termed handholes. The existing electric conduits from Handhole (HHG) 12 to new HHG C would be relocated to the east of the UH 88-inch and Gemini telescope sites. The Gemini facility would be served from new Handhole B (Figure 2.2-7). In addition, a standby generator of approximately 100 kVA would be installed above ground within the telescope facility. Standby power would be used to operate enclosure shutters and flushing vents and to keep sensitive instruments cold in the event of interruption to commercial power.

Communications

A minimum of eight telephone and data lines would be required to manage the operation of the telescope and to handle communications off-site. These lines would be provided by the local telephone company and installed in the existing underground conduits. New conduits would be constructed from existing Handhole 14 to the site (Figure 2.2-7). High-bandwidth (computer) communications would also be provided by connection to the Mauna Kea Observatories Communications Network, which uses a fiber-optic token ring installed in underground conduits.

Potable Water

A 6,000-gallon underground water storage tank is planned on the south side of the support facility (Figure 2.2-2). Potable water is trucked to the summit several times a week as required. Daily water consumption at the Gemini facility is projected at 200 gallons.



SOURCE: Gemini 8-Meter Telescopes Project
Telescope Structure, Building,
Enclosure Group, September 1993

0 25 50 100
Scale in Feet

ROUTE OF POWER AND COMMUNICATIONS TO GEMINI SITE

FIGURE 2.2-7

Domestic Wastewater

Personnel at the facility would generate approximately 200 gallons of wastewater per day, primarily human washings and waste. Disposal would be by means of a septic tank and leaching field, installed on the southwest side of the site in accordance with State and County requirements (Figure 2.2-2).

Process Wastewater

Mirror wash water would be collected in a holding tank and disposed of according to State of Hawaii Department of Health regulations. The procedures and chemicals used during mirror washing are described in Appendix A.

Facility Construction

Construction Facilities

From time to time during the construction period, especially when large pours are scheduled, the Gemini project would require the use of the approved temporary batch plant/staging area at the summit (Figure 2.1-3). The approximately 2-acre, previously-disturbed site, is situated within "Millimeter Valley" at about 13,250 feet above msl. The batch plant/staging area is presently being used by the Subaru telescope for its construction activities.

A trailer would be situated at the telescope site to serve as a construction field office. When construction activities are completed, the trailer would be removed from the site.

Construction Activities

Construction and installation of the 8-meter telescope facilities would be performed in five phases over a period of approximately five years (Table 2.2-1). The following is a description of the construction activities by phases:

TABLE 2.2-1

CONSTRUCTION PHASES

Phase	Activity	Time Needed
Phase I	Site utilities and roadway relocation; removal of UH 24-inch telescope	4 months
Phase II	Construction of the enclosure/telescope foundations and support building	15 months
Phase III	Installation of the telescope enclosure and mechanical support systems	10 months
Phase IV	Installation of the telescope structure and mirrors	15 months
Phase V	Commissioning of the telescope	12 months

Source: UH Conservation District Use Application, 1993

Phase I. Site work would begin with the relocation of the electric power conduits to the east side of the Gemini site (Figure 2.2-7). At the same time, the 24-inch telescope would be removed from the site and the site would be cleared.

Construction equipment would include bulldozers, backhoes, loaders, soil compactors, graders, rollers, dump trucks, water trucks, concrete trucks and flatbed trucks. The work force would consist of heavy equipment operators and skilled and unskilled workers. Local hires would be employed to the extent possible.

A temporary access road to the Canada-France-Hawaii Telescope would be constructed through the west portion of the Gemini construction site. Following this, the realigned section of the access road would be constructed. Construction would then proceed on the retaining wall, the foundations and foundation walls on the east side of the enclosure and support facility. Site drainage would be maintained by directing storm water runoff downslope in a swale alongside the relocated access road to an existing drainage culvert to the north of the Gemini site. The water would then flow downslope and percolate into porous soils.

Phase II. After the road is relocated, the remainder of the enclosure foundations and support facility foundations, the telescope foundation and pier, and the walls, floors and roof of the support facility would be constructed.

During construction, a total of 11,500 cubic yards of on-site soils would be disturbed. It is anticipated that 3,000 cubic yards of this on-site soil would be temporarily stockpiled at the concrete batching plant site and subsequently used to construct the roadbed of the relocated access road and as backfill material for concrete foundation walls. The ridge would generally be restored to the current ground elevations. Cut and fill slopes would not be steeper than 2 feet horizontal to 1 foot vertical (2H:1V) and 1.5H:1V, respectively, and would be benched for stability. The final amount of excess cut material to be taken off-site is estimated to be 8,500 cubic yards.

Although precast concrete structural elements would be used for concrete work where possible, approximately 2,500 cubic yards of cast-in-place concrete would be needed to complete the structures. This volume of concrete would require 313 truckloads of concrete mix from the batching plant to the telescope site, based on 8 cubic yards of concrete per truck.

Construction equipment during Phase II would include bulldozers, backhoes, soil compactors, graders, rollers, drilling machines, water trucks, loaders, dump trucks, hoisting equipment, air compressors, welding machines, fork lifts, concrete trucks and flatbed trucks. The work force would consist of heavy equipment operators and skilled and unskilled construction workers. Some of the specialized structural steel framing work may be directed by experienced workers from Oahu or west coast contractors that have experience working in Hawaii. To the extent possible, local hires would be employed.

Phase III. This phase involves the installation of the rotating enclosure that is fabricated outside of Hawaii and assembled at the Gemini site. The enclosure would be transported in sections on flatbed trucks. Skilled workers, such as riggers, welders and

painters would be needed to construct the enclosure. Once the enclosure is in place, other skilled workers would be needed inside the enclosure to finish the installation.

Phase IV. Phase IV would involve the installation of the telescope and the mechanical support structure. The telescope components and the support structure would also be transported on flatbed trailers in sections to be assembled at the Gemini site.

Phases III and IV would require hoisting equipment, such as a large mobile crane, air compressors, welding machines, forklifts and flatbed trucks. Skilled workers, such as riggers, welders, electricians and painters would be needed to install the telescope and support structure. When the telescope is installed in the enclosure, mechanical and electrical engineers and technicians would complete the installation. Local hires would be utilized during these phases to the maximum extent possible.

Phase V. Approximately one year would be required to commission the telescope to assure that it meets the specifications of the design. Astronomers, electrical and mechanical engineers, and electronic and mechanical technicians would be needed to perform the adjustment. Testing of the telescope would be performed within the telescope enclosure. The Gemini Northern 8-Meter Telescope is expected to be ready for operation by the end of 1999.

Operations and Maintenance

Economics and Employment

The plan for operating the Gemini Northern 8-Meter Telescope calls for an agreement with the Joint Astronomy Center in Hilo which already operates the United Kingdom Infrared Telescope and the James Clerk Maxwell Telescope. It is estimated that Hilo-based staffing for the Gemini project operations and maintenance would be about 31 people.

During the daytime hours, a crew of up to six people would work at the telescope site to perform necessary maintenance. It is expected that these people would sleep at the Hale Pohaku Mid-level facilities during the time they are working at the summit.

Some of the tasks performed by the day crew include primary mirror cleaning and changes to secondary mirror and major instrumentation. When the primary mirror is being recoated, up to ten people would be needed. Recoating of the primary mirror is performed every 6 to 24 months, depending on the reflective coating material used and cleaning method chosen. Recoating would require removing the 8-meter mirror from the telescope and lowering it through an opening in the observing floor to the stripping and wash area located in the lower level of the enclosure. Wastewater and other used materials would be disposed of in accordance with Department of Health requirements.

Because normal observations are performed between sunset and sunrise, astronomers and technicians would be at the telescope site at night. Depending on the nature of the observing program, at least two astronomers or operators would be present at the telescope in the evening. These people would sleep at Hale Pohaku for the duration of their observations.

2.3 ALTERNATIVES NO LONGER UNDER CONSIDERATION

The Gemini Northern 8-Meter Telescope is one of two telescopes being proposed, with the second telescope to be constructed in Chile. Because the project's goal is to provide access to key astronomical objects, regardless of their location in the celestial sphere, it is necessary to locate one telescope in the northern hemisphere and one in the southern hemisphere.

Only sites within the United States were considered for the location of the proposed northern hemisphere telescope. Two U.S. sites that were considered but rejected were Mount Graham and Kitt Peak, both in Arizona. Mount Graham has limitations in viewing potential due to humidity. In addition, surrounding terrain could affect windflow, which would limit image quality. Kitt Peak is at a lower elevation than the proposed project site and was rejected due to the limitations posed by the higher humidity levels. Fewer nights would be available for adequate infrared imaging.